FLIGHT SCHEDULES OF WINGED TERMITES (INSECTA: ISOPTERA) IN DOON VALLEY, UTTAR PRADESH[1]

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(With two text-figures)

The phenomenon of swarming in termites is an annual feature but precise information on their flight schedules and circumstances associated with the phenomenon is generally lacking for the great majority of Indian species. Significant contributions on this aspect have been made by Mathur and Sen-Sarma (1959, 1960, 1962), Sen-Sarma *et al.* (1975), Thakur (1978, 1985), Thakur and Sen-Sarma (1981) and Roonwal (1976, 1983).

INTRODUCTION

I have been actively engaged in termite research for well over a quarter of a century and have been collecting information on the swarming behaviour and the associated problems in the Doon Valley, Uttar Pradesh. This paper summarises the information on this important aspect of behavioural ecology of termites collected over the years, for 21 species. Information available in literature has also been incorporated.

SWARMING CHARACTERISTICS

The Doon Valley which comprises the whole of Dehradun district, is an open valley and lies between 29° 39' and 30° 31' N and 77° 34' and 78° 20'E. The valley is somewhat like a parallelogram in shape and is about 80 km in length, with an average width of about 7 km, widening in the eastern dun region. The valley is bounded by the outer ranges of the Himalaya on the north, by the Siwalik hills on the south and by the rivers Ganga and Yamuna on the eastern and western boundaries. The terrain is uneven. The climate is sub-tropical and humid during the greater part of the year, except during the dry hot months of May and June. Average annual rainfall is about 2000 mm. The soil in general is 'dun alluvium', and is generally clayey, tending to be loam, except in the hilly and sub-montane tract, and supports rich and luxurious vegetation, with large tracts of valuable sal forests and many other timber species and bamboos.

Family KALOTERMITIDAE

1. *Neotermes bosei* Snyder is a common species in northern India and has been recorded from dead branches of trees of several species. Emergence of alates in Doon Valley occurs late in the evening after sunset from the last week of January (26th) to the first week of July (4th), but major swarmings take place during early April to early June. Emergence is intermittent and in small batches (Roonwal and Sen-Sarma 1955, Mathur and Sen-Sarma 1959, Sen-Sarma *et al.* 1975). In eastern India (Kalimpong, North Bengal), alates of this species have been collected during November-December.

2. *Neotermes megaocculatus megaocculatus* Roonwal and Sen-Sarma has been recorded from dead branches of *Mangifera indica* in Doon Valley. No emergence record is available in Doon Valley; however, in the Kumaon hills, it has been recorded in the last week of May.

Family RHINOTERMITIDAE

3. *Heterotermes indicola* (Wasmann) is a major wood destroying termite in northern India (above 20° N, going up to 2500 m in the Himalayan region). It has also been recorded from many localities in Pakistan and parts of Afghanistan. The species swarms from the first week of July to the third week of August. In Doon Valley, the swarming has been recorded at night between 2100-2400 hrs in mid July on rainy days, particularly when the rain has continued for an hour or so (Sen-Sarma *et al.* 1975). However at Jodhpur, Roonwal (1976) has reported its swarming between 2000-2030 hrs in July-August. Observations recorded in Doon Valley and in most of the other localities in India indicate that this species swarms only during the night. However in Bombay, Assmuth (1913) recorded the swarming 'in the morning' at 0800 hrs or a little later, during the first showers of the monsoon. In Punjab, Arora and Gilotra (1960) recorded the

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swarming during mid August, when it was actually raining.

4. *Coptotermes heimi* (Wasmann) is one of the most widely distributed and major wood-destroying termite species in India, occurring throughout India and Pakistan. It has also been introduced into other countries of southeast Asia. This species usually swarms at dusk and in the early part of the night from January to August after heavy rain showers (Thakur 1985). In the Doon Valley its swarming occurs in June and July after heavy showers (Mathur and Sen-Sarma 1959). In Rajasthan (Jodhpur), this species has been reported to swarm even late at night after 2100 hrs and occasionally when it is drizzling (Roonwal 1976, 1983). At Coimbatore, Thakur (1985) has recorded the swarms of this species from the third week (1830-1930 hrs) of January to the last week of February, when the weather is quite dry. He has also reported synchronized flight schedules exactly on the same date (5 and 23 February 1980 and 1983) and at the same time (1845 hrs) from two different colonies situated *c.* 18 km apart.

Specific records of swarming in this species are available in literature within its entire range of distribution. Depending upon the local meteorological conditions in a locality, this species seems to swarm, in south India (Coimbatore, approx. 11 ° N.) from 3rd week of January to the last week of February (*vide supra*), in the warmer and more humid parts of Bombay, Orissa and West Bengal (approx. 19-22° N.) from March to May and in the drier parts of Haryana, Punjab, Rajasthan and Uttar Pradesh (26°5'N) on dry days during summer months from May (2nd half) to August. Swarming occurs intermittently in small batches.

Family STYLOTERMITIDAE

5. *Stylotermes dunensis* Thakur is a rare wood-inhabiting termite known only from Dehradun in the Doon Valley. This species has been collected from avenue trees such as *Acer oblongum, Mangifera indica*, etc. Swarming in nature has not been observed. However, winged alates have been collected from infested logs during the second half of July in the laboratory.

Family MACROTERMITIDAE

6. *Odontotermes assmuthi* Holmgren is very widely distributed almost all over India and swarms during the greater part of the year from the last week of February to the middle of December. In Doon Valley, this species has two flight periods, i.e. winter flight season from second half of February to early March and summer flight season in June, usually in the second half of the month. During the summer flight season, it usually swarms at 1630 hrs on bright sunny days preceded by heavy shower of rain (Sen-Sarma 1962). Occasionally, its swarms have also been recorded in the morning (0700-0830 hrs) on cloudy days or even during light drizzle (Thakur 1978, 1985). During winter flight season, winged alates have been collected at light. Elsewhere, at Coimbatore, the swarms of this species have been recorded at dusk to early in the night (1830-1930 hrs) in the second half of October, invariably 6-12 hours after rain (Thakur 1985). These records of flight schedules show that there is no rigid time schedule for swarming in this species. It may swarm in the early morning (0700-0830 hrs), late in the afternoon at 1630 hrs or at dusk (1830-1930 hrs).

7. *Odontotermes bhagwatii* Chatterjee and Thakur. This species occurs in Himachal Pradesh, Jammu and Kashmir, Punjab, Uttar Pradesh (Doon Valley) and Karnataka. In Doon Valley, this species swarms at dusk (1830-1900 hrs) during June-August, from small holes in the ground after heavy rains. Specific dates of swarmings as available in literature are: 4 August 1912, 19 July 1918, 29 July 1940, 6 July 1973 and 11 June 1984.

8. *Odontotermes dehraduni* Snyder has been recorded from North India (Dehra Dun, Delhi, Jodhpur) and Pakistan. This species is known from imago caste only. Swarming is reported to occur in the evening (1830-2030 hrs) from the last week of June to the end of September, from small holes in the grounds after a heavy shower. The alates are attracted towards light in large numbers. In Doon Valley, it swarms during the last week of June almost to the end of July.

9. *Odontotermes distans* Holmgren and Holmgren. This species is very widely distributed throughout India, Pakistan, Bangladesh, Bhutan and Burma. In India, this species is more common in northern and eastern India, inhabiting submontane areas in the Himalayan ranges, reaching up to 2100 m.

It swarms during the greater part of the year, from the middle of February to first week of Decem-

ber. In the Doon Valley, like *O. assmuthi*, this species has two flight seasons. It swarms primarily in the afternoon (1600-1630 hrs) to dusk in the last week of February to early April (winter flight season) and again in the last week (25th) of July at about 1930-2030 hrs (summer flight season). The swarming is usually preceded by rain (6-12 hours) and is, at times, also followed by rain (3-6 hours). Another interesting feature recorded by the author is the synchronization of flight schedules on the same dates (26 February 1970 and 1973) in the New Forest Estate (Dehra Dun). Elsewhere, its swarms have been recorded at dusk in February-March (West Bengal, eastern India), August (Jodhpur, Rajasthan) and from middle of October to the third week of November (Coimbatore, Tamil Nadu).

10. *Odontotermes indicus* Thakur is also very widely distributed throughout India, except eastern India. Swarming has been recorded in June and September (Orissa). In Doon Valley, this species swarms during monsoon months of July and August. Swarming is crepuscular or nocturnal, usually beginning at dusk or a little later and continuing sometimes throughout the night. At times, the swarming occurs even when it is drizzling. The alates come out simultaneously from holes at different places in the ground.

11. *Odontotermes microdentatus* Roonwal and Sen-Sarma. This species is a mound building termite, occurring in the greater part of India, building low dome shaped conical or cylindrical mounds, sometimes with large vertical buttresses (Sen-Sarma *et al.* 1975). In Doon Valley, this species swarms at night (2300 hrs) during the second half of June (Aggarwal 1975).

12. *Odontotermes obesus* (Rambur) is a very widely distributed species in south-east Asia, occurring throughout India, up to 2000 m in the Himalaya (except very cold regions), Pakistan, Bangladesh and Burma. This species swarms from May to end of November. In Doon Valley, the swarming takes place during June and July. The swarming begins with the onset of monsoon in June. It begins at dusk or at night (1830-2200 hrs) and continues sometimes throughout the night usually after heavy showers. Flights also occur when rain is actually falling. Some actual records of swarming schedules as available in literature within India are as follows: May (1st week) at Almora (Kumaon Hills, Uttar Pradesh), June-July (Doon Valley), Bhopal (Madhya Pradesh), July-August (Jodhpur, Rajasthan), October (Cochin, Kerala) and last week of October to end of November (Coimbatore, Tamil Nadu).

13. *Microtermes obesi* Holmgren. This species occurs widely in south and southeast Asia (Pakistan, India, Bangladesh, Sri Lanka, Burma and Thailand). Swarming occurs mostly from early July to early August in northern India, but alates have been collected from the nest in April-May-June (Roonwal 1970, Roonwal and Verma 1977). In Doon Valley (Dehra Dun), this species swarms late in the afternoon (1300-1530 hrs) during July. Elsewhere (Jodhpur, Rajasthan), it has been found to swarm early in the day (1030-1330 hrs).

14. *Microtermes unicolar* Snyder is found in Pakistan, northwestern India and Bangladesh. It occurs commonly in pouches in the outer region of mounds of *Odontotermes* and under wood debris in forest areas. Swarming occurs in summer and rainy months from April to August. In Doon Valley, swarms have been recorded at night (1900-2100 hrs) in the months of June, usually after rainfall.

Family TERMITIDAE

15. *Speculitermes cyclops* Wasmann is widely distributed in India, from eastern Rajasthan, Uttar Pradesh, Madhya Pradesh (up to 1050 m altitude, Pachmarhi), Maharashtra and some parts of Karnataka (Coorg). The species occurs in well wooded or semi-open humid forest vegetation, where the soil retains higher percentage of moisture and comparatively moderate temperature. Precise swarming records are lacking in literature; however, the alates have been collected from the nest, from the last week of May to third week of June at Dehradun. In Bombay, Assmuth (1913) is reported to have collected imago caste on 12 May.

16. *Euhamitermes lighti* Snyder is known only from Doon Valley. It belongs to a group of subterranean humus feeding termites, found only a few centimetres below well drained amorphous land. Actual swarming records are lacking in literature, but fully matured alates have been encountered in the field from 2nd week of May to end of June. It may, therefore, be surmised that this species swarms some time during the rainy months of June and July.

17. *Eremotermes dehraduni* Roonwal and Sen-Sarma. This species is also known only from the

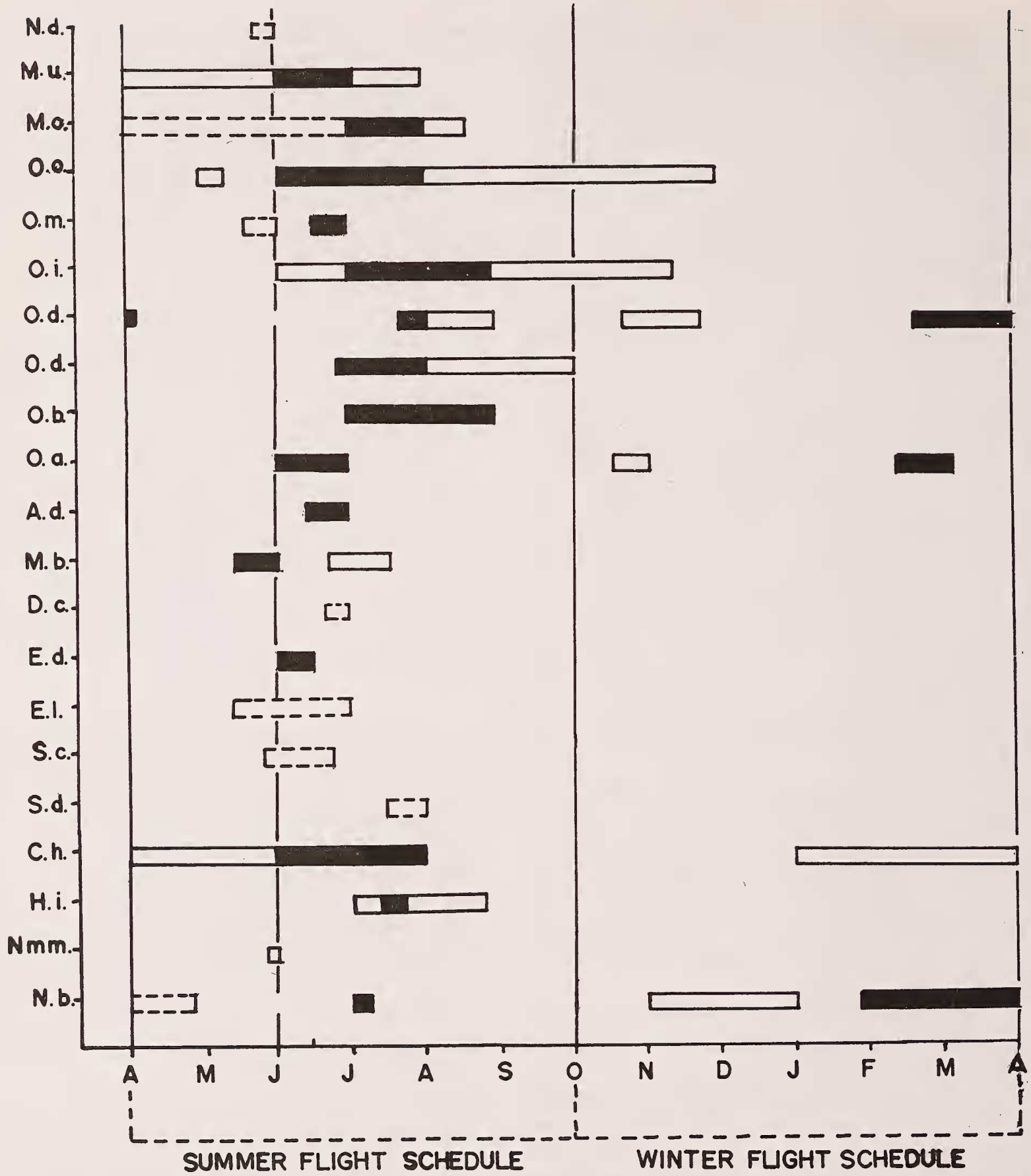

Fig. 1. Swarming schedules of termites in Doon Valley. Hollow bars: show swarming periods of species at other localities within the entire range of their distribution. Solid bars: show swarming periods in Doon Valley.
N.b. *Neotermes bosei*; N.m.m. *Neotermes megaoculatus megaoculatus*; H.i. *Heterotermes indicola*; C.h. *Coptotermes heimi*; S.d. *Stylotermes dunensis*; S.C. *Speculitermes cyclops*; E.l. *Euhamitermes lighti*; E.d. *Eremotermes dehraduni*; D.c. *Doonitermes capillosus*; M.b. *Microcerotermes beesoni*; A.d. *Angulitermes dehraensis*; O.a. *Odontotermes assmuthi*; O.b. *Odontotermes bhagwatii*; O.i. *Odontotermes indicus*; O.m. *Odontotermes microdentatus*; O.o. *Odontotermes obesus*; M.o. *Microtermes obesi*; M.u. *Microtermes unicolor*; N.d. *Nasutitermes dunensis*.

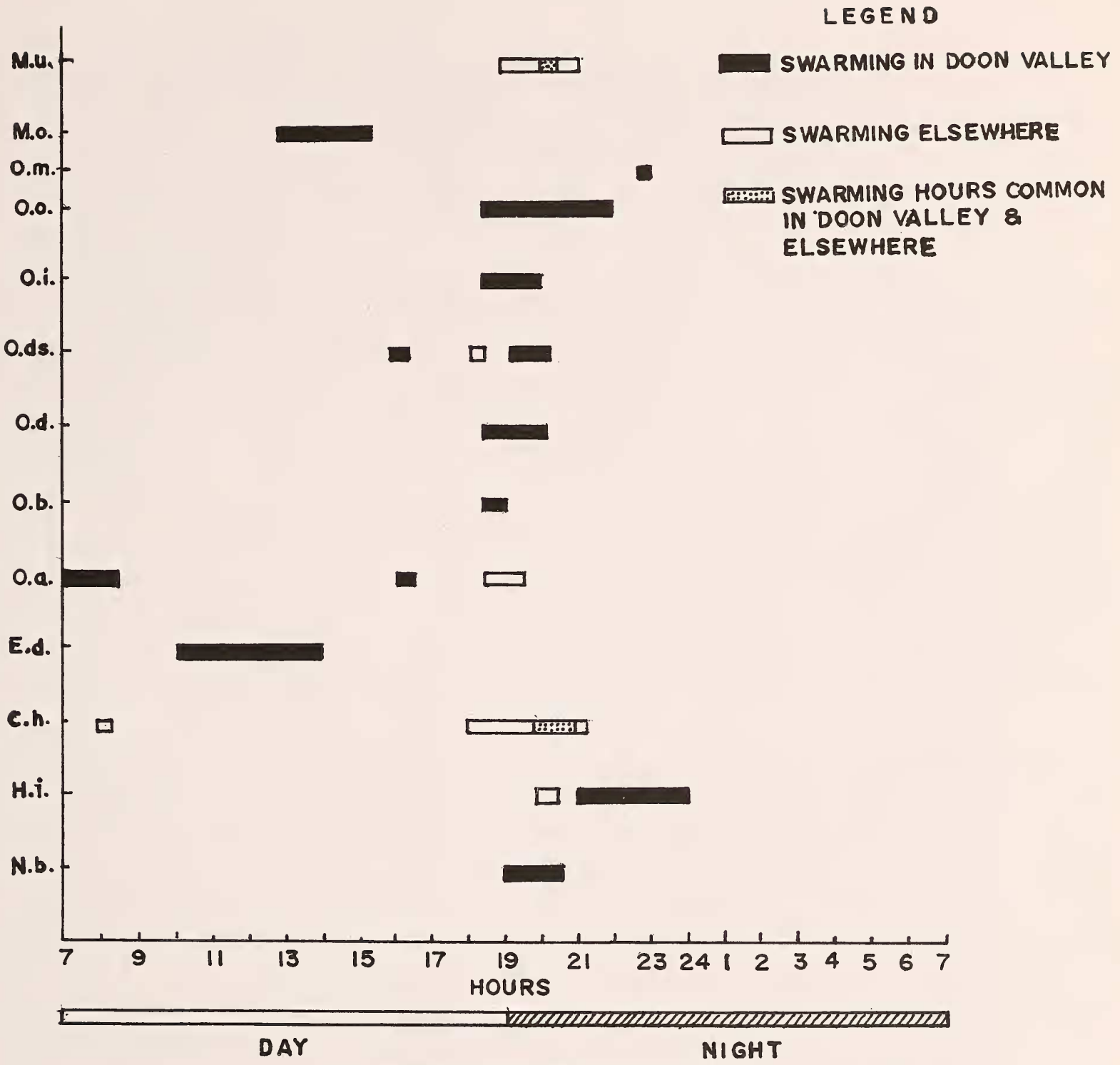

Fig. 2. Swarming hours of termites in Doon Valley

Doon Valley. It has been collected from wet areas in the valley. The swarming in this species occurs in the first half of June during bright sunshine from 1000 to 1400 hrs from small holes in the ground, usually after a shower of rain.

18. *Doonitermes capillosus* Chatterjee and Thakur. This species lives in medium sized communities in the sal forests in the Doon Valley and, like its closely allied genus *Speculitermes*, is represented by a very small percentage of soldier caste. Actual records of its swarming are not available in the literature, but fully mature adults have been collected from the field in the last week of June. It may therefore be presumed that this species swarms some time during the month of July.

19. *Microcerotermes beesoni* Snyder. This species occurs in northern India in partly buried carton nests. In Doon Valley, it swarms in the second half of May. However, from other localities outside the valley, the swarming records of this species range from the last week of June to middle of July.

20. *Angulitermes dehraensis* (Gardner). This species is very common in Doon Valley and is also known from some localities in Pakistan (Layallpur and Sekesar). It occurs under stones, cowdung, outer region of mounds of genus *Odontotermes* as well as

TABLE 1
FLIGHT SCHEDULES (WITH PERIOD) OF TERMITES IN DOON VALLEY

Summer flight schedule period April-Sept.	Winter flight schedule period Oct.-March	Common flight schedule period	Elsewhere
Heterotermes indicola (July-Aug.)	Nil	*Neotermes bosei* (Feb.-Apr. & July)	*Neotermes megaoculatus megaoculatus* (May-last week)
Coptotermes heimi (June-July)		*Odontotermes assmuthi* (Feb.-Mar. & June)	*Odontotermes bhagwatii* (July-Aug.)
Stylotermes dunensis (July, 2nd half)		*O. distans* (Feb.-April &July)	
Speculitermes cyclops (May last week to June 3rd week.)			
Euhamitermes lighti (June 3rd week to July last week)			
Eremotermes dehraduni (June, 2nd half)			
Microcerotermes beesoni (May last week)			
Doonitermes capillosus (July)			
Angulitermes dehraensis (June)			
Odontotermes bhagwatii (June-Aug.)			
O. dehraduni (June-July) *O. indicus* (July-Aug.)			
O. microdentatus (June, 2nd half)			
O. obesus (June-July)			
Microtermes obesi (July)			
M. unicolar (June)			
Nasutitermes dunensis (June-July)			

under compact soil of road sides and agricultural fields near forested areas. It swarms sometimes during the 2nd half of June, when the mature sexual form is seen in small numbers (Mathur and Sen-Sarma 1959). However, precise hours of actual flights are not known.

21. *Nasutitermes dunensis* Chatterjee and Thakur. It occurs in the forest areas of Doon Valley. Actual records of swarming are not known. However, as fully mature alates have been collected in the field in the last week of May, it may be presumed that this species swarms some time during the following months of June and July, probably after showers.

DISCUSSION

The Doon Valley has a subtropical climate where temperature plays a significant role in sharply dividing the seasons, and influencing to a great extent, the flight pattern in termites. Accordingly, Doon Valley has two flight seasons, more or less linked to meteorological rhythms of rainy months, i.e. (i) *Winter flight schedule*, from October to March (sometimes extended to early April) and (ii) *Summer*

flight schedule, from April to September. This is in contrast to flight rhythms of termites at Coimbatore, south India, where there is only one flight schedule (generally from second half of September to end of March), coinciding generally with northeast monsoon. Most of the species (17) have only summer flight schedules from April to September, mostly during the monsoon months (June to August), none have solely winter flight and *Neotermes bosei* Snyder (February-April and July), *Odontotermes assmuthi* Holmgren (February-March and June) and *Odontotermes distans* Holmgren and Holmgren (February-April and July) have both summer and winter flight schedules (Table 1).

Similarly precise hours of flight schedules in 13 species, for which the data is available (Fig. 2), shows that nine species swarm generally late in the day to early in the night, two species, *Eremotermes dehraduni* Roonwal and Sen-Sarma and *Microtermes obesi* Holmgren swarm early in the day to early afternoon (1000 to 1530 hrs), two species, *Heterotermes indicola* (Wasmann) and *Odontotermes microdentatus* Roonwal and Sen-Sarma swarm at night (2100-2400 hrs and 2300 hrs respectively). In the case of *Odontotermes indicus* and *Odontotermes obesus*, the swarming sometimes continues till late in the night (upto 2300 hrs) or even throughout the night.

The time schedules of swarming in termites at any one locality are, by and large, precise, and are repeated year after year (Nutting 1969, Thakur and Sen-Sarma 1981 and Thakur 1985), but sometimes there is a departure from the normal schedules and a species may behave differently. For example, *Odontotermes assmuthi* Holmgren usually swarms at 1630 hrs during bright sunshine, but occasionally, it may also swarm in the morning (0700-0830 hrs) and even when it is cloudy or drizzling. However, such exceptions are few and rare. Similarly, some species (e.g. *Odontotermes distans*) exhibit striking time fixity. On two occasions, this species was found to swarm from two different colonies situated nearly 3 km apart on 26 February 1970 and 26 February 1973 in Dehradun. However, the hours of flight schedule were not synchronized, whereas the first swarm on 26 February 1970 occurred in the evening at sunset, the second swarm occurred on 26 February 1973 in the afternoon at 1630 hrs.

From the information available in literature, it appears that flight schedules in some species are closely linked to latitudinal and regional elevation differences over their entire range of distribution (Nutting 1969, Thakur 1985). For example, *Coptotermes heimi* has been reported to swarm from March to May in the warmer and more humid areas of Bombay, Orissa and West Bengal (approx. 19-22° N.), during monsoon months, from June to August, in the drier parts of Haryana, Punjab, Rajasthan and Uttar Pradesh (approx. 26° 5'-31° N) and further down at Coimbatore, South India (approx. 11° N) from January to February. Similarly *Odontotermes obesus* swarms during the early part of hot summer from late April (28th) to May in the western temperate climate of Himalaya (Himachal Pradesh and Western Himalaya of Garhwal, Kumaon Hills and Doon Valley in Uttar Pradesh), from June to August in the Gangetic plains in Uttar Pradesh and from October to November at Coimbatore (South India).

All these establish a positive correlation between the swarming and rainfall, but what exactly triggers swarming, is a complex problem and is only speculative at present. Many physical changes in the weather conditions in a locality, such as air pressure and humidity, moisture content in the soil and other climatic conditions, are invariably associated with the phenomenon of swarming. Any single factor or combination of factors influences the microclimatic condition in the nest, which, together with the vibration produced by the rain drops, perhaps act as stimuli for swarming. Changing conditions rather than any fixed set of absolute values provide the major climatic stimulus for flight schedules (Nutting 1969, Thakur 1985). Since observations on the swarming of termites in nature are chance records, it is not surprising that information on the precise hours of flight have so far been collected in case of 12 species only. More information is required on the swarming behaviour of more termites, particularly in the case of those species where it is lacking, from different climatic conditions at various latitudinal localities.

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